Experiments in the Use of Old Soil in Growing Carnations and Roses

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CONTENTS

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IN GROWING carnations it is customary to renew the soil as well as the plants each year. Whether this annual discarding of soil is an economical practice is a question that may well be asked. Greenhouse soil is as a rule raised to a high state of fertility by the use of manure and commercial fertilizers, and at the end of a season a large percentage of the plant nutrient elements remains in the soil. Not only is much time and labor spent in changing soil, but it is often very difficult for urban florists to obtain new soil suitable for use in the benches or for potting.

The experiments reported in the first part of this bulletin were therefore begun to determine whether the yields and quality of carnations were affected adversely by being grown on old soils. As the results seemed to vary with the plot, variety, and season, the tests were continued over a longer period than was at first contemplated. As it became apparent that yields, if not quality, were reduced to some extent on old soil, efforts were made to produce crops fully comparable to those on new soil by the use of fertilizers and other soil treatments. This result was attained when old soil was steamed.

Roses present a slightly different problem, as the plants are customarily grown for three years or longer in the same soil. Some growers, however, advocate transplanting rose plants into new soil each year, and a few growers follow this method. The experiments with roses described on pages 20 to 24 were made to determine whether the changing of rose soil annually is worth while. Judging from the results obtained, it is not an economical practice.

I. FLOWER PRODUCTION OF CARNATIONS ON NEW AND OLD SOILS

Description of Carnation Experiments

Beginning in 1919 varying numbers of carnations were grown each year on old soil for comparison with a like number grown on new soil. New plots were added each season, and until 1927 carnations

were grown on a complete series of soils of different ages. From 1927 to 1932 only certain ones of the older plots were retained.

The greater part of a 100-foot house, containing four 4-foot benches, was devoted to these experiments. As a rule the different plots were moved about in the house each season. Benches were repaired as necessary at the time the plots were shifted. A layer of strawy manure was placed on the bottom of the bench before the soil was replaced. A chart of the house is given in Fig. 1, and the location of the plots each season may be found by referring to the chart.

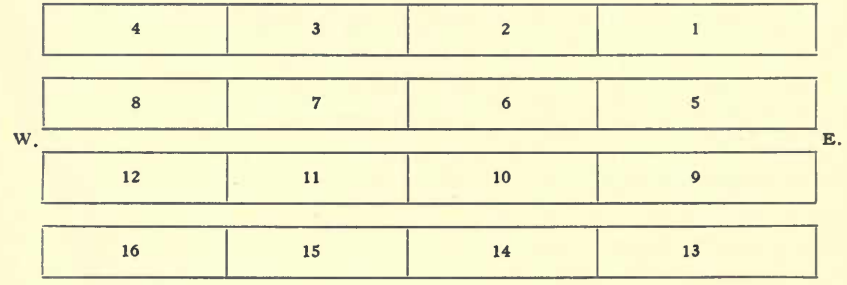

FIG. 1.—LOCATION OF PLOTS IN CARNATION HOUSE, 1919-1933

The field soil used thruout the experiments was a fertile upland prairie brown silt loam.[1] Manure was added to the soil in the bench or, in the later years, to the soil in the field. Details of the handling of the soil each season are given below.

In the earlier years the plants in the experimental plots were used for propagating. Cuttings were taken in January, approximately equal numbers from each plot. In 1930-31 and after, separate lots of stock plants were grown for propagating purposes. Plants uniform in size and development were transplanted from the field the latter part of July or early in August. A night temperature of 52° F. was maintained during the growing season. The day temperature was kept at 58° F., or 63° and above on sunny days. Accurate records were kept of the number and quality of flowers produced. Plants put in the bench to replace those that died were not included in the records. Stem lengths and flower diameters were measured thruout the season, or during the midwinter months. The periods included in the records are shown in Table 1.

[1]Ill. Agr. Exp. Sta. Soil Report No. 18. 1918.

TABLE 1.—PERIODS INCLUDED IN CARNATION RECORDS, 1919-1933

Year	Flower production	Flower measurements
1919-20	Oct. 6 to Apr. 13	Oct. 6 to Apr. 13
1920-21	Oct. 6 to Mar. 20	Oct. 6 to Mar. 20
1921-22	Sept. 22 to Mar. 15	Nov. 2 to Mar. 15
1922-23	Oct. 2 to Mar. 26	Nov. 1 to Mar. 26
1923-24	Oct. 1 to Apr. 16	Nov. 2 to Apr. 16
1924-25	Oct. 13 to May 1	Nov. 3 to Mar. 26
1925-26	Oct. 14 to Apr. 13	Dec. 12 to Mar. 30
1926-27	Nov. 2 to Mar. 21	Jan. 11 to Mar. 21
1927-28	Oct. 1 to May 31	Jan. 3 to Mar. 31
1928-29	Oct. 17 to May 17	Dec. 1 to Feb. 28
1929-30	Oct. 2 to May 29	Dec. 10 to Jan. 25
1930-31	Oct. 7 to May 29	Jan. 5 to Jan. 31
1931-32	Oct. 15 to May 28	Jan. 2 to Feb. 29
1932-33	Oct. 1 to May 31	Feb. 8 to Feb. 28

Carnation Yields on New and Old Soils

Yields of carnations may vary considerably in different parts of a house, even tho the soil treatment is uniform. These differences may be due to differences in temperature, light, and inherent differences in individual plants, factors which it is impractical to regulate. This makes it difficult or impossible to draw definite conclusions from soil experiments in any one season or with any given arrangement of plots. In the tables in this bulletin certain of the flower yields are printed in blacker type to indicate those which are statistically significant and which were most likely affected by soil differences. In many cases the decreases in yields on old soils were small and, in a good proportion of the trials, the yields on old soils were as good as or better than those on new.

No apparent relation existed between the age of the old soil and yields of flowers. Averaging the results obtained with all varieties during the years of experimentation, about 11 percent fewer flowers were cut from plants on old soils than from plants on new soil. There were no noticeable differences in quality between flowers from old soils and flowers from new soil. The average stem length of flowers produced on new soil was 18.1 inches and the diameter 3.1 inches. The average stem length of flowers produced on old soils was 17.5 inches and the diameter 3.1 inches.[1]

[1]In a similar experiment reported in Rhode Island Agricultural Experiment Station Bulletin 187 (1921), the yield of grade 1 and grade 2 flowers was reduced on old soil about 5 percent. Judging from the tables presented, the reduction in total yield on old soil was about 7 or 8 percent. The Ohio Station reported poor results with old soil with no manure or other fertilizer added (Ohio Agr. Exp. Sta. Bul. 449, 1930).

First Year, 1919-20.—Soil which had been planted to White Perfection in 1918-19 was replanted with No. 1—12. After the old plants were pulled out, the soil was limed and 9 bucketfuls of manure, 4 pounds of superphosphate, and 2 pounds of dried blood per 100 square feet of bench space were added. The plot was spaded over several times and the soil kept moist until the new plants were placed in it on July 27. For comparison an equal number of plants were grown on new soil similarly fertilized.

The crop on new soil was larger by about .53 flower per plant (7.3 percent) than the crop on old soil. The stems averaged a little longer and the flowers a trifle larger. (Table 2.)

TABLE 2.—CARNATION YIELDS ON NEW AND OLD SOILS, 1919-1924

Variety and year	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
					inches	*inches*
1919-20						
No. 1—12	New	2	100	7.28 ± .19	18.6	2.9
	2-yr.	1	100	**6.75** ± .19	17.9	2.8
1920-21						
Laddie	New	3	95	5.83 ± .15	20.8	3.6
	2-yr.	2	96	**4.80** ± .12	19.5	3.4
	3-yr.	1	92	5.00 ± .14	19.5	3.4
1921-22						
Laddie	New	3	100	6.60 ± .12	19.7	3.5
	2-yr.	4	104	6.35 ± .14	19.8	3.5
	3-yr.	2	100	6.72 ± .15	18.8	3.4
	4-yr.	1	98	6.80 ± .15	18.7	3.3
White Enchantress	New	5, 6	196	11.15 ± .14	17.2	3.5
	2-yr.	7, 8	194	**10.41** ± .14	17.6	3.5
1922-23						
Laddie	New	(1)	96	6.58 ± .15	19.7	3.3
	2-yr.	3	100	6.66 ± .14	18.4	3.3
	3-yr.	4	100	6.68 ± .13	18.3	3.2
	4-yr.	2	99	6.22 ± .13	18.2	3.2
	5-yr.	1	96	6.37 ± .12	17.6	3.2
White Enchantress	New	5, 6	198	11.29 ± .15	16.2	3.3
	3-yr.	7, 8	192	**8.64** ± .15	15.8	3.2
1923-24						
Laddie	New	1b, 8a[2]	96	7.26 ± .15	19.2	3.3
	2-yr.	2a, 7b	96	6.72 ± .12	19.1	3.3
	3-yr.	2b, 7a	95	6.89 ± .11	19.0	3.3
	4-yr.	3a, 6b	95	6.82 ± .14	19.0	3.4
	5-yr.	3b, 6a	96	**6.36** ± .14	18.8	3.4
	6-yr.	4a, 5b	96	**6.32** ± .12	18.6	3.3

[1]Adjoining house. [2]Plots subdivided.

Second Year, 1920-21.—The second year a top dressing of rotted manure was spaded into the old soils. No manure was added to the new soil, and none of the plots were limed. Each plot received superphosphate and dried blood at rates of 10 pounds and 1 pound, respec-

tively, per 100 square feet. The soils were prepared early in July and Laddie plants set in the bench on July 30.

The crop was larger on new soil. On 2-year soil the decrease was 1.03 flowers a plant (17.7 percent), and on 3-year soil, .83 flower a plant (14.2 percent). Stem lengths and flower diameters likewise averaged slightly higher on new soil. (Table 2.)

Third Year, 1921-22.—In preparing both old and new soils for planting, 2 wheelbarrow loads of rotted manure, 10 pounds of superphosphate, and 1 pound of dried blood were used per 100 square feet of bench space. The fertilizers were spaded in on July 23. Laddie and White Enchantress were planted on July 25.

Where Laddie was used, the differences in yield between plants on new soil and those on soils 2, 3, or 4 years old did not seem significant. Stem lengths and flower diameters averaged a trifle less on the older soils. White Enchantress produced a much smaller crop on 2-year soil than on new soil, the difference being .74 flower a plant (6.6 percent). Stem lengths and flower diameters on old soils were equal to those on new soil. (Table 2.)

Fourth Year, 1922-23.—The soils were treated as they were the previous season and planted again with Laddie and White Enchantress. No significant differences were observed between the yields of Laddie on new soil and on soils 2, 3, 4, or 5 years old. The flowers were again a trifle larger and the stems longer, however, on the new soil. The crop of White Enchantress was much smaller on 3-year soil than on new soil, the difference amounting to 2.65 flowers a plant (16.3 percent). Stem lengths and flower diameters were slightly greater on new soil. (Table 2.)

Fifth Year, 1923-24.—The soils were prepared as in the two previous years and the plots planted with Laddie. The decreases in yields on the old soils were of doubtful significance except in the case of the 5- and 6-year soils. The decreases on these two plots were about .9 flower a plant (12.4 percent). Stem lengths in these cases were slightly shorter than on new soil. (Table 2.)

Sixth Year, 1924-25.—All plots received 10 pounds of superphosphate and 8 pounds of dried blood per 100 square feet. The varieties grown were Laddie and White Enchantress. Altho yields of Laddie were generally slightly lower on old soils, the only marked difference was on the 5-year soil. In this case the decrease was 1.18 flowers a plant (19.1 percent). With White Enchantress the greatest variations were noted with the 6- and 7-year soils. On the 6-year soil the yield was higher than on new soil by 1.37 flowers a plant (25.5 percent),

and on the 7-year soil it was lower by 1.41 flowers a plant (26.2 percent). On all other old soil plots the yields of White Enchantress were as good as or better than the yield on new soil. (Table 3.)

TABLE 3.—CARNATION YIELDS ON NEW AND OLD SOILS, 1924-1926

Variety and year	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
					inches	*inches*
1924-25						
Laddie	New	1a, 8b[1]	71	6.18 ± .15	19.3	3.2
	2-yr.	1b, 8a	71	5.70 ± .15	18.2	3.3
	3-yr.	2a, 7b	72	6.15 ± .17	17.6	3.3
	4-yr.	2b, 7a	72	5.93 ± .18	18.4	3.3
	5-yr.	3a, 6b	71	5.00 ± .15	17.6	3.3
	6-yr.	3b, 6a	72	6.04 ± .20	18.5	3.3
	7-yr.	4a, 5b	72	6.37 ± .18	17.4	3.2
White Enchantress	New	1a, 8b	28	9.96 ± .40	15.8	3.2
	2-yr.	1b, 8a	24	10.92 ± .47	15.6	3.3
	3-yr.	2a, 7b	23	10.44 ± .34	14.6	3.4
	4-yr.	2b, 7a	24	10.67 ± .38	15.0	3.3
	5-yr.	3a, 6b	24	10.54 ± .35	15.5	3.3
	6-yr.	3b, 6a	24	11.33 ± .32	15.2	3.3
	7-yr.	4a, 5b	22	8.55 ± .35	15.4	3.3
1925-26						
Laddie	New	4b, 5a	48	5.37 ± .22	23.8	3.3
	2-yr.	1a, 8b	52	4.85 ± .23	24.6	3.3
	3-yr.	1b, 8a	47	5.09 ± .22	23.4	3.2
	4-yr.	2a, 7b	48	5.90 ± .19	24.2	3.4
	5-yr.	2b, 7a	47	5.92 ± .22	24.5	3.4
	6-yr.	3a, 6b	48	6.42 ± .19	23.5	3.4
	7-yr.	3b, 6a	48	5.94 ± .18	24.8	3.4
	8-yr.	4a, 5b	48	5.50 ± .19	24.7	3.3
White Enchantress	New	4b, 5a	47	7.87 ± .20	20.5	3.4
	2-yr.	1a, 8b	48	7.50 ± .23	20.2	3.3
	3-yr.	1b, 8a	48	8.42 ± .16	20.4	3.3
	4-yr.	2a, 7b	48	8.62 ± .21	20.6	3.4
	5-yr.	2b, 7a	48	8.75 ± .22	21.1	3.4
	6-yr.	3a, 6b	48	8.44 ± .17	20.9	3.4
	7-yr.	3b, 6a	48	7.70 ± .19	20.3	3.4
	8-yr.	4a, 5b	46	7.98 ± .17	19.4	3.5

[1]Plots subdivided.

Seventh Year, 1925-26.—All plots received a top dressing of rotted manure, one inch thick, 10 pounds of superphosphate, and 5 pounds of dried blood per 100 square feet. Potassium sulfate was used on the 8-year soil at the rate of 5 pounds to 100 square feet of plot. The yields on the old soil plots varied only slightly from the yields on new soil. The greatest difference was with Laddie on 6-year soil, where 1.05 more flowers were cut per plant (19.6 percent) than were cut from Laddie on new soil. There were no consistent differences in stem lengths or flower diameters. (Table 3.)

Eighth Year, 1926-27.—All plots received 20 pounds of ground limestone and 10 pounds of dried blood per 100 square feet. The fer-

tilizers were applied July 27 and the carnations planted August 4. The yields for the season varied. A significant decrease of 1.33 flowers a plant (29.3 percent) from the yield on new soil was noted with Betty Lou on 4-year soil and similar decreases with Laddie of 1.39 and 1.62 flowers a plant (33.9 and 39.5 percent) on 2- and 4-year soils. With Spectrum, yields on 2-, 3-, 6-, and 8-year soils were lower

TABLE 4.—CARNATION YIELDS ON NEW AND OLD SOILS, 1926-27

Variety	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
					inches	*inches*
Betty Lou	New	9, 10, 11, 12	54	4.54 ± .27	16.0	2.9
	2-yr.	6, 15	64	3.96 ± .19	14.6	2.8
	3-yr.	5, 16	64	3.97 ± .15	15.1	2.9
	4-yr.	14	29	3.21 ± .28	15.5	3.0
	5-yr.	8	36	4.72 ± .25	16.0	2.9
	6-yr.	2	35	3.77 ± .26	15.5	3.0
	7-yr.	3	34	4.35 ± .24	15.9	3.0
	8-yr.	4	34	3.71 ± .20	15.6	2.9
	9-yr.	7	34	3.53 ± .22	16.7	3.1
Laddie	New	9, 10, 11, 12	64	4.10 ± .18	21.3	3.4
	2-yr.	6, 15	63	2.71 ± .17	19.5	3.2
	3-yr.	5, 16	59	4.10 ± .17	18.8	3.2
	4-yr.	14	27	2.48 ± .27	19.6	3.2
	5-yr.	8	32	3.34 ± .26	20.4	3.3
	6-yr.	2	32	3.34 ± .19	20.3	3.3
	7-yr.	3	30	3.70 ± .20	20.9	3.3
	8-yr.	4	31	4.22 ± .19	21.2	3.2
	9-yr.	7	30	3.33 ± .23	21.8	3.5
Spectrum	New	9, 10, 11, 12	64	8.30 ± .26	19.2	3.0
	2-yr.	6, 15	59	6.37 ± .24	18.4	3.0
	3-yr.	5, 16	62	6.50 ± .26	17.8	3.0
	4-yr.	14	24	5.67 ± .33	18.1	3.1
	5-yr.	8	32	7.47 ± .35	18.6	3.1
	6-yr.	2	31	6.55 ± .25	18.5	3.1
	7-yr.	3	31	7.64 ± .31	18.6	3.1
	8-yr.	4	30	7.03 ± .30	18.5	3.1
	9-yr.	7	28	7.64 ± .37	18.9	3.1

than the yield on new soil. The differences were 1.93, 1.80, 1.75, and 1.27 flowers a plant (23.2, 21.7, 21.1, and 15.3 percent) respectively. No consistent differences in stem lengths or flower diameters occurred. (Table 4.)

Ninth Year, 1927-28.—All plots received manure. Carnations were planted August 5. Yields of Betty Lou on 9- and 10-year soils were lower by 1.51 and 2.09 flowers per plant (13.2 and 18.2 percent) than the yields on new soil. On 2-year soil Spectrum yielded 2.22 more flowers per plant (18.3 percent) than on new soil. There were no marked differences in stem lengths or flower diameters. (Table 5.)

Tenth Year, 1928-29.—New, 10-, and 11-year soils received 10 pounds of superphosphate and 5 pounds of dried blood per 100 square

feet of bench. Two-year soil received manure in addition to the other fertilizers. New and 2-year acid soils received hydrated lime at the rate of 10 pounds to 100 square feet. The fertilizers were worked into the soil on August 13 and carnations were planted on August 16. The yields of Early Rose on 2-, 10-, and 11-year soils were lower than on new soil by 2.10, 3.23, and 4.79 flowers a plant (10.7, 16.5, and 24.4 percent) respectively. Harvester showed a decrease of 1.51 flowers a plant (11.3 percent) on 2-year soil. With Laddie the differences were not marked. There were no consistent differences in stem lengths or flower diameters on new and on old soils. (Table 5.)

TABLE 5.—CARNATION YIELDS ON NEW AND OLD SOILS, 1927-1929

Variety and year	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
					inches	*inches*
1927-28						
Betty Lou	New	7, 8	40	11.46 ± .25	14.5	3.1
	2-yr.	11, 12	40	12.10 ± .30	14.5	3.1
	9-yr.	3	37	9.95 ± .37	14.4	3.1
	10-yr.	4	38	9.37 ± .30	14.3	3.1
Laddie	New	7, 8	50	6.76 ± .19	19.3	3.5
	2-yr.	11, 12	50	6.61 ± .21	18.9	3.4
	9-yr.	3	43	6.00 ± .28	19.2	3.4
	10-yr.	4	44	6.10 ± .29	18.9	3.5
Spectrum	New	7, 8	40	12.10 ± .38	17.7	3.1
	2-yr.	11, 12	34	14.32 ± .45	17.7	3.1
	9-yr.	3	38	13.26 ± .31	17.8	3.2
	10-yr.	4	40	12.15 ± .37	17.2	3.0
1928-29						
Early Rose	New	10, 11, 12	132	19.61 ± .29	11.9	2.6
	2-yr.	2, 6, 14	134	17.51 ± .26	11.8	2.7
	10-yr.	3	44	16.38 ± .40	11.5	2.7
	11-yr.	4	45	14.82 ± .49	10.8	2.5
Harvester	New	10, 11, 12	144	13.38 ± .21	12.8	2.7
	2-yr.	2, 6, 14	150	11.87 ± .18	13.7	2.7
	10-yr.	3	50	12.54 ± .38	12.5	2.7
	11-yr.	4	49	12.45 ± .38	12.8	2.7
Laddie	New	10, 11, 12	82	3.20 ± .17	15.9	3.2
	2-yr.	2, 6, 14	80	2.67 ± .12	15.3	3.2
	10-yr.	3	23	3.26 ± .32	14.3	3.0
	11-yr.	4	28	2.96 ± .26	15.0	3.0

Eleventh Year, 1929-30.—New, 11-, and 12-year soils received 10 pounds of superphosphate and 5 pounds of dried blood per 100 square feet of bench. A mulch consisting of equal parts of rotted manure and peat was turned into the 2-year soil. Carnations were planted on August 5. The yields of Early Rose were smaller on 2-, 11-, and 12-year soils by 3.48, 4.48, and 3.88 flowers a plant (17.0, 21.9, and 18.9 percent), respectively, than on new soil. With Harvester there was

a significant decrease on 12-year soil of 2.83 flowers a plant (22.7 percent). With Spectrum there were significant decreases on 2-year and 12-year soils of 1.58 and 1.85 flowers a plant (13.0 and 15.2 percent) respectively. There were no consistent differences in stem lengths or flower diameters on new and on old soils. (Table 6.)

TABLE 6.—CARNATION YIELDS ON NEW AND OLD SOILS, 1929-1931

Variety and year	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
1929-30					*inches*	*inches*
Early Rose	New	11, 12	97	20.48 ± .44	14.3	2.6
	2-yr.	16	47	17.00 ± .54	13.8	2.7
	11-yr.	7	38	16.00 ± .48	13.3	2.6
	12-yr.	8	49	16.60 ± .45	14.5	2.6
Harvester	New	11, 12	46	12.45 ± .65	15.3	2.8
	2-yr.	16	23	13.50 ± .87	15.7	2.9
	11-yr.	7	23	12.09 ± .69	14.5	2.7
	12-yr.	8	24	9.62 ± .61	14.3	2.8
Spectrum	New	11, 12	85	12.11 ± .31	18.6	3.0
	2-yr.	16	43	10.53 ± .37	18.3	3.0
	11-yr.	7	34	10.60 ± .43	16.3	2.8
	12-yr.	8	38	10.26 ± .38	18.8	2.9
1930-31						
Early Rose	New	7	35	20.37 ± .48	14.2	2.7
	2-yr.	2	32	18.84 ± .52	12.6	2.6
	12-yr.	8	30	22.30 ± .63	12.2	2.5
	13-yr.	4	35	18.20 ± .47	12.5	2.5
Harvester	New	7	44	20.43 ± .54	15.2	2.7
	2-yr.	2	43	18.86 ± .44	14.5	2.7
	12-yr.	8	43	18.84 ± .30	15.4	2.7
	13-yr.	4	41	18.61 ± .46	15.6	2.7
Spectrum	New	7	44	18.75 ± .41	18.1	2.9
	2-yr.	2	43	19.02 ± .38	17.0	2.8
	12-yr.	8	45	18.84 ± .36	17.4	2.8
	13-yr.	4	45	19.13 ± .37	17.9	2.8

Twelfth Year, 1930-31.—New and old soils alike received 10 pounds of superphosphate and 5 pounds of blood per 100 square feet of bench. The old soils also received sulfate of potash at the rate of 2 pounds to 100 square feet. The commercial fertilizers were worked into the soil and watered in a few days before the carnations were planted on August 6. The only marked difference between yields on old and new soils was with Harvester on 13-year soil. The decrease in this instance was 1.82 flowers a plant (8.9 percent). The differences, if any, in stem lengths and flower diameters on old and on new soils were slight. (Table 6.)

Thirteenth Year, 1931-32.—All plots received 10 pounds of superphosphate per 100 square feet. The carnations were planted on Aug-

ust 3. They were fed several times during the season with a solution of urea at the rate of 1 ounce to 12 gallons of water. The greatest differences in yield were with Harvester. On 2-year soil this variety showed a decrease of 2.13 flowers a plant and on 14-year soil a decrease of 2.43 flowers a plant (13.0 and 14.9 percent) compared with new soil. With Pink Abundance the differences were smaller. With Spectrum the yields were larger on old than on new soil. Stem lengths and flower diameters averaged a little larger on new soil. (Table 7.)

TABLE 7.—CARNATION YIELDS ON NEW AND OLD SOILS, 1931-1933

Variety and year	Soil	Plot	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
1931-32					*inches*	*inches*
Harvester	New	11	39	16.33 ± .49	15.6	2.8
	2-yr.	10	36	14.20 ± .34	14.5	2.7
	14-yr.	12	40	13.90 ± .42	15.6	2.7
Pink Abundance	New	11	45	15.35 ± .33	19.9	2.8
	2-yr.	10	45	14.15 ± .32	18.5	2.8
	14-yr.	12	41	15.12 ± .40	18.4	2.8
Spectrum	New	11	36	14.42 ± .49	20.0	2.9
	2-yr.	10	36	16.20 ± .41	17.3	2.8
	14-yr.	12	31	16.55 ± .55	18.7	2.8
1932-33						
Harvester	New	3	39	16.69 ± .46	15.9	2.9
	2-yr.	8	35	14.05 ± .55	13.5	2.9
	15-yr.	5	35	10.17 ± .45	17.0	2.7
Pink Abundance	New	3	44	14.43 ± .48	19.6	3.0
	2-yr.	8	44	15.98 ± .38	18.6	3.0
	15-yr.	5	41	15.05 ± .40	19.2	2.9
Spectrum	New	3	40	16.72 ± .38	19.2	3.1
	2-yr.	8	39	16.67 ± .45	17.0	3.1
	15-yr.	5	38	15.84 ± .45	17.3	2.9

Fourteenth Year, 1932-33.—All plots received 10 pounds of superphosphate per 100 square feet and several applications of urea as for the thirteenth year. The plants were set in the benches from the field on August 5. Harvester showed significant decreases in yields on the old soils, these decreases amounting to 2.64 and 6.52 flowers (15.8 and 39.1 percent) on 2- and 15-year soils respectively. There were no appreciable differences with the other two varieties. The flowers from the oldest soil plot averaged slightly smaller than flowers from new soil. (Table 7.)

Effects of Liming Carnation Soil

Lime may act to neutralize acidity or to combat the effects of other harmful substances in the soil. In general the evidence available indi-

cates that while the carnation plant is not very sensitive to differences in soil reaction, a good supply of lime in the soil may be of some use in improving stems and the yield as well.[1, 2]

Lime, in the experiments reported in this bulletin, seemed to be of some benefit to carnations, especially on used soils (Table 8). The field soil used for filling the benches was acid, about pH 5.5. At the

TABLE 8.—CARNATION YIELDS ON LIMED AND UNLIMED SOILS, 1925-1928

Variety and year	Soil	Plots	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
1925-26					*inches*	*inches*
Laddie	New	9a, 11b, 14a, 16b	93	6.00 ± .13	23.3	3.3
	2-yr.	12, 13	93	4.87 ± .12	23.0	3.3
	2-yr., lime	10a, 11a, 14b, 15b	96	6.43 ± .17	24.3	3.4
White Enchantress	New	9a, 11b, 14a, 16b	96	9.12 ± .18	20.2	3.3
	2-yr.	12, 13	93	8.28 ± .18	20.4	3.4
	2-yr., lime	10a, 11a, 14b, 15b	96	8.06 ± .16	21.0	3.4
1926-27						
Betty Lou	New	9a, 10a, 11b, 12a	64	4.54 ± .27	16.0	2.9
	New, lime	9b, 10b, 11b, 12b	64	5.00 ± .28	16.3	2.9
Laddie	New	9a, 10a, 11a, 12a	64	4.10 ± .18	21.3	3.4
	New, lime	9b, 10b, 11b, 12b	61	3.92 ± .17	21.4	3.4
Spectrum	New	9a, 10a, 11a, 12a	64	8.30 ± .26	19.2	3.0
	New, lime	9b, 10b, 11b, 12b	64	9.31 ± .23	19.6	3.1
1927-28						
Betty Lou	New	5a, 6a, 7a, 8a	79	11.00 ± .21	14.7	3.1
	New, lime	5b, 6b, 7b, 8b	77	11.62 ± .23	15.0	3.1
	2-yr.	9a, 10a, 11a, 12a	79	11.78 ± .23	14.4	3.0
	2-yr., lime	9b, 10b, 11b, 12b	77	12.16 ± .25	14.5	3.1
Laddie	New	5a, 6a, 7a, 8a	98	6.28 ± .14	19.3	3.4
	New, lime	5b, 6b, 7b, 8b	99	6.48 ± .12	20.0	3.5
	2-yr.	9a, 10a, 11a, 12a	99	5.80 ± .16	18.5	3.4
	2-yr., lime	9b, 10b, 11b, 12b	95	6.67 ± .18	19.2	3.4
Spectrum	New	5a, 6a, 7a, 8a	70	13.73 ± .32	16.8	3.0
	New, lime	5b, 6b, 7b, 8b	80	14.24 ± .27	17.4	3.1
	2-yr.	9a, 10a, 11a, 12a	80	13.14 ± .28	17.3	3.1
	2-yr., lime	9b, 10b, 11b, 12b	80	12.98 ± .22	17.8	3.1

end of a season the reaction was ordinarily about pH 6.0 without liming.

The number of flowers cut during the three seasons was somewhat larger where lime was used. About 11 percent more flowers were cut from 2-year soil that was limed than from 2-year soil that was unlimed. About 4 percent more flowers were cut from new soil limed

[1]Wiggin, W. W., and Gourley, J. H. Studies on the reaction of greenhouse soils to the growth of plants. Ohio Agr. Exp. Sta. Bul. 484. 1931.

[2]Weinard, F. F., and Decker, S. W. The growth of several floricultural crops on limed and acidified soils. Proc. Amer. Soc. Hort. Sci. 28, 416-417. 1932.

than from new soil unlimed. Carnations on 2-year soil limed gave about 5 percent more flowers than the plants on new soil unlimed. The average stem length in two seasons (1926-1928) from untreated new soil was 17.9 inches, and the average flower diameter was 3.1 inches. The stem length of flowers cut from new soil limed was 18.3 inches, and the flower diameter was 3.2 inches. For the seasons 1925-26 and 1927-28 the stems of flowers cut on 2-year soil unlimed averaged 19.2 inches, and the flower diameter, 3.2 inches, compared with 19.9 inches and 3.3 inches from 2-year soil limed.

First Year, 1925-26.—Laddie gave significantly larger yields on used soil limed than on used soil unlimed, or on new soil. The yield of White Enchantress, however, was higher on new unlimed soil. The average stem lengths and flower diameters were slightly greater on the 2-year limed plots. (Table 8.)

Second Year, 1926-27.—Twenty pounds of ground limestone per 100 square feet used on certain plots produced no marked differences in yields of Betty Lou, Laddie, or Spectrum on new soil. There was a tendency for the stems to be longer on the limed plots. (Table 8.)

Third Year, 1927-28.—At the beginning of the season 2-year soil which had not been limed the previous year showed a reaction of pH 6.0, while the soil in plots which had received limestone was practically neutral in reaction. Ten pounds of hydrated lime per 100 square feet of bench was used on the treated plots, and differences large enough to be considered significant were obtained in two instances. Betty Lou on used soil limed gave a distinctly larger yield than on new soil unlimed. Smaller increases were observed in other cases, mostly on the limed plots. The stems were consistently a little longer where lime was used. (Table 8.)

Other Fertilizer Materials.—Various other fertilizer materials carrying nitrogen, phosphorus, and potash were used on old soils in efforts to increase their productivity. Some plots were allowed to dry out, others were kept moist in summer, and partial sterilization with such substances as formaldehyde and calcium cyanide was also tried. As none of these treatments seemed to be of any benefit, no detailed results are given.

Effects of Steaming Carnation Soil

Steaming carnation soil gave good results with both old and new soils in experiments conducted at this Station.

For these experiments a galvanized iron pan approximately 4 feet wide, 6 feet long, and 10 inches deep was used. The soil was pulverized

shortly before planting time and the inverted pan pressed down over it. The steam pressure was rather low, about 5 pounds. The steam was turned on for two hours at each setting, and the soil reached a temperature of about 200° F. Fertilizers were added to the soil after steaming. The results are shown in Table 9.

Taking into consideration the results from all varieties for four seasons, about 9 percent more flowers were cut, on the average, from 2-year soil that was steamed than from similar soil that was unsteamed. About 7 percent more flowers were cut from 2-year soil that was steamed than from new soil. There was an increase with new steamed soil also, amounting on the average to about 9 percent. Steamed 14- and 15-year soil gave 2.2 more flowers a plant (15.5 percent) than similar unsteamed soil.

Over the four seasons the average length of stems cut from new steamed soil was 17.9 inches, compared with 17.2 inches from unsteamed new soil. The corresponding flower diameters were 2.8 inches and 2.8 inches. The average stem length from 2-year steamed soil was 17.6 inches, compared with 16.1 inches on 2-year unsteamed soil. The corresponding flower diameters were 2.8 inches and 2.8 inches. The average stem length from 14- and 15-year soil steamed was 16.7 inches compared with 17.7 inches from similar soil unsteamed. The corresponding flower diameters were 2.8 inches and 2.8 inches. The beneficial effects observed from steaming soil may have been the result of changes in the population of soil organisms or of increases in available plant nutrients. No studies were made along these lines.

First Year, 1929-30.—With Early Rose the cut was increased, on both old and new steamed soils, 2.18 and 2.36 flowers a plant (11.7 and 13.9 percent) respectively. Results with the other two varieties were inconsistent. Stems averaged considerably longer on 2-year steamed soil than on untreated 2-year soil. (Table 9.)

Second Year, 1930-31.—Distinct increases were obtained in this season with Early Rose and Spectrum from steaming both old and new soils. The increases with new steamed soil were 2.35 and 1.15 flowers a plant (10.9 and 5.8 percent) respectively. The corresponding increases with 2-year steamed soil were 4.87 and 1.79 flowers a plant (25.8 and 9.4 percent). Also, 2.19 more flowers per plant (10. 2 percent) were cut from Early Rose on 2-year steamed soil than from new unsteamed soil, and there was a similar but smaller difference with Spectrum. Steaming seemed to increase the length of stems on 2-year soil. (Table 9.)

TABLE 9.—CARNATION YIELDS ON STEAMED AND UNSTEAMED SOILS, 1929-1933

Variety and year	Soil	Plots	Number of plants	Average number flowers a plant	Average stem length	Average flower diameter
					inches	*inches*
1929-30						
Early Rose	New	5, 6, 11, 12	189	18.67 ± .26	14.2	2.6
	New, steam	9, 10	91	20.85 ± .40	14.6	2.6
	2-yr.	16	47	17.00 ± .54	13.8	2.7
	2-yr., steam	13, 14, 15	144	19.36 ± .29	14.4	2.6
Harvester	New	5, 6, 11, 12	98	11.83 ± .36	15.5	2.8
	New, steam	9, 10	41	13.00 ± .41	16.0	2.7
	2-yr.	16	23	13.50 ± .87	15.7	2.9
	2-yr., steam	13, 14, 15	71	12.86 ± .37	17.0	2.8
Spectrum	New	5, 6, 11, 12	165	11.94 ± .21	18.5	3.0
	New, steam	9, 10	83	11.65 ± .27	18.4	2.9
	2-yr.	16	43	10.53 ± .37	18.3	3.0
	2-yr., steam	13, 14, 15	117	12.00 ± .37	19.2	3.0
1930-31						
Early Rose	New	3, 6, 7, 11	140	21.52 ± .28	13.9	2.6
	New, steam	10, 12	69	23.87 ± .39	14.8	2.5
	2-yr.	2	32	18.84 ± .52	12.6	2.6
	2-yr., steam	14, 15, 16	103	23.71 ± .28	14.4	2.6
Harvester	New	3, 6, 7, 11	171	20.84 ± .25	15.4	2.7
	New, steam	10, 12	84	20.43 ± .33	15.7	2.7
	2-yr.	2	43	18.86 ± .44	14.5	2.7
	2-yr., steam	14, 15, 16	132	20.24 ± .22	15.4	2.7
Spectrum	New	3, 6, 7, 11	179	19.89 ± .21	18.0	2.8
	New, steam	10, 12	90	21.04 ± .27	18.0	2.8
	2-yr.	2	43	19.02 ± .38	17.0	2.8
	2-yr., steam	14, 15, 16	134	20.81 ± .22	18.2	2.8
1931-32						
Harvester	New	11	39	16.33 ± .49	15.6	2.8
	New, steam	15	39	15.95 ± .41	18.0	2.7
	2-yr.	10	36	14.20 ± .34	14.5	2.7
	2-yr., steam	14	37	15.97 ± .50	16.2	2.6
	14-yr.	12	40	13.90 ± .42	15.6	2.7
	14-yr., steam	16	40	15.05 ± .35	16.3	2.7
Pink Abundance	New	11	45	15.35 ± .33	19.9	2.8
	New, steam	15	45	15.95 ± .39	21.0	2.7
	2-yr.	10	45	14.15 ± .32	18.5	2.8
	2-yr., steam	14	44	15.18 ± .43	20.5	2.8
	14-yr.	12	41	15.12 ± .40	18.4	2.8
	14-yr., steam	16	45	15.42 ± .42	20.2	2.7
Spectrum	New	11	36	14.42 ± .49	20.0	2.9
	New, steam	15	38	17.68 ± .42	20.3	2.8
	2-yr.	10	36	16.20 ± .41	17.3	2.8
	2-yr., steam	14	31	18.90 ± .61	19.3	2.7
	14-yr.	12	31	16.55 ± .55	18.7	2.8
	14-yr., steam	16	40	16.46 ± .53	18.9	2.8
1932-33						
Harvester	New	2, 3	79	15.78 ± .31	16.9	2.9
	New, steam	14, 15	76	18.41 ± .38	17.4	2.9
	2-yr.	4, 8	73	14.83 ± .34	14.5	2.9
	2-yr., steam	12, 16	79	18.16 ± .38	17.4	2.9
	15-yr.	5	35	10.17 ± .45	17.0	2.7
	15-yr., steam	9	29	16.65 ± .72	11.8	2.3
Pink Abundance	New	2, 3	87	13.55 ± .40	19.3	2.9
	New, steam	14, 15	90	17.17 ± .38	20.7	2.9
	2-yr.	4, 8	89	16.17 ± .26	18.8	3.0
	2-yr., steam	12, 16	89	19.29 ± .33	20.1	2.9
	15-yr.	5	41	15.05 ± .40	19.2	2.9
	15-yr., steam	9	35	17.54 ± .60	19.8	3.1
Spectrum	New	2, 3	80	16.36 ± .29	19.5	3.1
	New, steam	14, 15	80	19.11 ± .31	19.5	3.0
	2-yr.	4, 8	78	16.87 ± .29	17.7	3.1
	2-yr., steam	12, 16	80	19.44 ± .32	19.2	3.0
	15-yr.	5	38	15.84 ± .45	17.3	2.9
	15-yr., steam	9	30	19.10 ± .56	13.4	3.0

Third Year, 1931-32.—More flowers were cut from Spectrum on 2-year and new steamed soil than from similar unsteamed plots. The differences amounted to 3.26 and 2.70 flowers a plant (22.6 and 16.7 percent). Steamed 2-year soil gave 4.48 more flowers a plant (31.1 percent) than new unsteamed soil. Results in other cases were inconsistent, tho more often than not they appeared to be better on steamed soil. Steaming increased the average stem length on both old and new soils. (Table 9.)

Fourth Year, 1932-33.—Regardless of the age of the soil, more flowers were cut from steamed than from unsteamed soil with all three varieties grown. Harvester increases on new, 2-year, and 15-year soils that were steamed were 2.63, 3.33 and 6.48 flowers a plant (16.7, 22.4, and 63.7 percent). With Pink Abundance the corresponding increases were 3.62, 3.12, and 2.49 flowers a plant (26.7, 19.3, and 16.2 percent). With Spectrum similar increases were obtained, amounting to 2.75, 2.57, and 3.26 flowers a plant (16.8, 15.2, and 20.6 percent). With all three varieties, the yields on the 2-year soil and, in most instances, on 15-year soil steamed were larger than those on new soil. The increases in the three varieties from steaming 2-year soil were 2.38, 5.74, and 3.08 flowers a plant (15.1, 42.4, and 18.8 percent). The increases from steaming 15-year soil of Pink Abundance and Spectrum were 3.99 and 2.74 flowers (29.4 and 16.7 percent). (Table 9.)

Losses of Plants on New and Old Soils

The losses of plants in the benches were practically all caused by stem rot (*Rhizoctonia solani* Kühn = *Corticium vagum* B. and C.) and they occurred mostly early in the season shortly after planting. New plants were reset in the same spot, and sometimes it was necessary to replant more than once. Flowers cut from such replants, however, were not included in yield records.

The percentages of plants that died from season to season varied a great deal (Table 10), depending in large part, no doubt, on weather conditions before and after planting. In one season, for example, 20 percent of the first planting of Harvester was lost. There were, however, no consistent increases in the occurrence of stem rot with age of soil. Most years a few more plants were lost in the old soil plots than in the plots of new soil, but the differences were generally small. Over a period of years the loss of plants on old soils averaged a little over 4 percent, compared with about 3 percent on new soil.

Over a 2-year period, 1926 to 1928, the loss where new soil was limed averaged about the same as on the unlimed plots, or about 3

TABLE 10.—LOSSES OF PLANTS AND PERCENTAGES OF SPLIT FLOWERS IN THE CROPS ON NEW AND OLD SOILS, 1919-1933

Year	Variety	Soil	Percentage of plants lost	Percentage of flowers split
1919-20	No. 1—12	New	0	8.0
		2-yr.	0	4.6
1920-21	Laddie	New	5.0	17.9
		2- to 3-yr.	6.0	16.5
1921-22	Laddie	New	0	13.8
		2- to 4-yr.	0	9.5
	White Enchantress	New	2.0	8.9
		2-yr.	3.0	6.5
1922-23	Laddie	New	0	12.3
		2- to 5-yr.	1.2	8.4
	White Enchantress	New	1.0	7.9
		3-yr.	5.9	9.6
1923-24	Laddie	New	0	8.3
		2- to 6-yr.	.4	6.5
1924-25	Laddie	New	1.4	5.0
		2- to 7-yr.	0	9.2
	White Enchantress	New	0	2.1
		2- to 7-yr.	.7	6.4
1925-26	Laddie	New	0	1.9
		2- to 8-yr.	.6	3.8
	White Enchantress	New	0	5.4
		2- to 8-yr.	.6	8.9
1926-27	Betty Lou	New	15.6	17.6
		2- to 9-yr.	8.6	14.8
	Laddie	New	0	13.4
		2- to 9-yr.	5.0	7.3
	Spectrum	New	0	9.0
		2- to 9-yr.	7.2	9.1
1927-28	Betty Lou	New	0	26.8
		2-, 9-, 10-yr.	4.2	16.6
	Laddie	New	0	13.3
		2-, 9-, 10-yr.	2.1	12.9
	Spectrum	New	0	28.5
		2-, 9-, 10-yr.	1.7	10.5
1928-29	Early Rose	New	2.2	.1
		2-, 10-, 11-yr.	.9	.2
	Harvester	New	4.0	.2
		2-, 10-, 11-yr.	.4	0
	Laddie	New	11.2	11.1
		2-, 10-, 11-yr.	12.6	7.4
1929-30	Early Rose	New	3.0	.7
		2-, 11-, 12-yr.	10.7	.4
	Harvester	New	23.3	.4
		2-, 11-, 12-yr.	22.2	.3
	Spectrum	New	5.6	13.0
		2-, 11-, 12-yr.	14.8	7.9
1930-31	Early Rose	New	0	.4
		2-, 12-, 13-yr.	7.6	.5
	Harvester	New	2.2	0
		2-, 12-, 13-yr.	5.9	.4
	Spectrum	New	2.2	10.8
		2-, 12-, 13-yr.	1.5	5.8
1931-32	Harvester	New	2.5	19.1
		2-, 14-yr.	5.0	1.4
	Pink Abundance	New	0	3.5
		2-, 14-yr.	4.4	1.8
	Spectrum	New	10.0	17.9
		2-, 14-yr.	16.2	14.7
1932-33	Harvester	New	1.2	.3
		2-, 15-yr.	10.0	.9
	Pink Abundance	New	3.3	2.2
		2-, 15-yr.	3.7	1.6
	Spectrum	New	0	25.1
		2-, 15-yr.	2.5	18.6

percent. In 1925-26 and 1927-28 the loss on 2-year limed soil was about 1 percent, compared with about 4 percent on 2-year unlimed soil. Apparently liming had no effect on the loss from stem rot.

Also, contrary to what might be expected, steaming the soil did not greatly reduce losses. Over a period of four years the loss on new steamed soil was about 6 percent and on new unsteamed soil about 5 percent. The loss during the same period on 2-year soil that was steamed was about the same as on similar soil unsteamed, or about 6 percent. On the 14- and 15-year steamed soil (1931-1933) about 2 percent of the plants died, compared with 9 percent on the unsteamed plots. Since a large ball of soil is brought in on each carnation plant transplanted from the field, plants and soil may carry the fungus, and it is not surprising that under these conditions steaming the bench soil does not eliminate stem rot.

These observations with limed and steamed soils are in accord with results obtained by Peltier.[1]

Occurrence of Split Flowers on New and Old Soils

The splitting of calyxes is known to all carnation growers more or less as a variety trouble. The relative importance of various factors which may induce splitting has not been determined, but weather conditions and the state of nutrition of the plant[2] evidently have some influence. In the present series of experiments the percentages of split flowers in the crops ran a little higher on new soil (Table 10). About 7 percent of the flowers cut on old soils were split, compared with about 9 percent on new soil. This was possibly a result of a little slower development of plants on old soil.

About 14 percent of the flowers on new limed soil were split, and about 17 percent on the unlimed plots used for comparison for the period 1926-1928 were split. On the other hand about 13 percent of the crops cut on 2-year limed soil (1925-26, 1927-28) were split, compared with 9 percent on 2-year unlimed soil. No definite effects could be ascribed to lime from such conflicting results.

Steaming, likewise, seemed to have little or no effect on the number of split flowers. Over a 4-year period about 8 percent of the crop on new soil was split, and 6 percent on similar steamed soil was split. With 2-year soils about 5 percent of the flowers on both the steamed and unsteamed plots were split. About 7 percent were split on the 14- and 15-year unsteamed plots and 6 percent on similar soil steamed.

[1]Peltier, G. L. Carnation stem rot and its control. Ill. Agr. Exp. Sta. Bul. 223. 1919. [2]50th Ann. Rept. N. J. State Agr. Exp. Sta., p. 235, 1929.

Summary and Conclusions in Carnation Experiments

Carnations on old soils produced, on the average, about 11 percent fewer flowers than similar plants on new soil. There was no progressive decrease in yields with increasing age of bench soils. There were no important differences in stem lengths or diameters of flowers cut on old and new soils.

Liming seemed to have a beneficial effect on yield, especially with old soils. There was also evidence that it may have some effect in improving the quality of the crop.

Steaming carnation soil was very effective in increasing the numbers and improving the quality of flowers produced. Crops cut from old soils treated with steam were as good as or better than crops from new soil.

Only a few more plants were lost, on the average, on old soils than on new soil. There was no progressive increase in the numbers of replants on used soil with an increase in age of soil. Neither liming nor steaming had any marked effect on the number of plants lost.

The percentages of split flowers averaged a little lower in the crops grown on old soil. Liming or steaming seemed to have no definite effect on the production of split blooms.

Some soils may deteriorate with use more than others, depending somewhat on the way they are handled. The grower must determine for himself whether the probable decrease in the value of the crop on old soil will equal or exceed the cost of changing the soil.

Where old soil can be treated with steam it can be kept in a highly productive condition indefinitely. The method is a practical one for many growers who are so located that it is difficult for them to get new soil. Other possibilities, not included in the experiments described, are the use of hot water and electricity for treating used soil and the rotation of crops.

II. FLOWER PRODUCTION OF ROSES ON NEW AND OLD SOILS

Experiment With Premier Roses

Description of Experiment.—A 100-foot bench near the center of an east-and-west house was planted with Premier roses on July 18, 1924. Young grafted and own-root plants were set in alternate rows across the bench. At the end of the first season half the plants were reset in fresh soil (Fig. 2). At the end of the second season certain

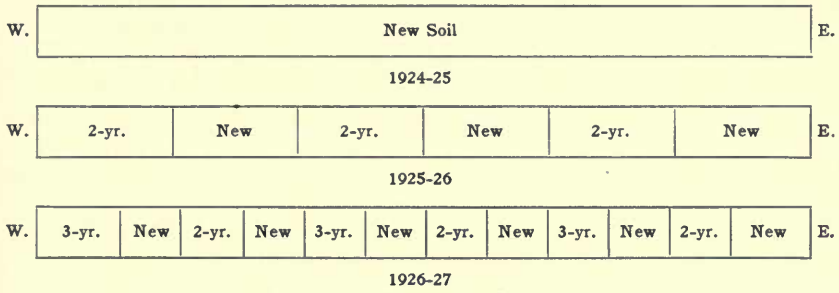

FIG. 2.—LOCATION OF PLOTS IN OLD-SOIL EXPERIMENT WITH PREMIER ROSES

of the plants were again transplanted to new soil. In this way comparisons were possible with plants on new, 2-year, and 3-year-soils.

The field soil used was a brown silt loam with which manure had been incorporated in the field in the proportions of about one part manure to four of soil. Twenty or 25 pounds of superphosphate and 5 pounds of dried blood per 100 square feet of bench were mixed into the soil each time before the plants were set. Manure mulches and liquid manure were used as required to keep the plants in active growth. Temperatures maintained during the growing season were 58° F. at night and 68° F. in the daytime, except on bright days, when the temperature rose to 73° to 78° F.

At the end of the season the plants were dried off slowly and then cut back to a height of about 18 inches. Those to be transplanted were heeled in outside until the soil was changed, after which they were returned to the same relative positions on the bench. Superphosphate and dried blood were added to both new and old soils, as at the beginning of the first season.

Records of flower production were kept from September 24 to June 13 in 1924-25, and from September 28 to June 15 in 1925-26. The crop shown in Table 11 was cut between October 4 and April 4 in 1926-27. On the latter date a severe hailstorm broke most of the glass in the houses. Plants were broken and an epidemic of mildew and black spot followed. Between April 4 and May 14 about 4 flowers a plant were cut from the grafted plants and about 2.5 flowers a plant from the own-root plants.

Yields on New and Old Soils.—Figures on flower production of Premier roses for three seasons are given in Table 11.

In the second year several more flowers per plant were cut from the grafted plants in new soil than from similar plants in old soil, but the variation between individual plants was so great that the

TABLE 11.—FLOWER PRODUCTION OF PREMIER ROSES ON NEW AND OLD SOILS

Soil	Grafted plants			Own-root plants		
	Number of plants	Average number flowers per plant	Average stem length	Number of plants	Average number flowers per plant	Average stem length
			inches			*inches*
1924-25						
New	160	29.28 ± .53	11.8	159	27.54 ± .40	12.3
1925-26						
New	76	35.03 ± .78	11.6	84	26.31 ± .37	11.3
2-yr	84	31.70 ± .86	11.2	75	26.64 ± .49	11.3
1926-27						
New	80	17.73 ± .43	11.3	76	12.94 ± .35	11.1
2-yr	36	17.55 ± .55	10.2	44	13.52 ± .47	10.6
3-yr	44	17.70 ± .65	10.7	39	13.30 ± .47	10.6

difference was not large enough to be considered significant. There was no difference between the cuts from own-root plants on new and old soils.

In the third year there were no differences between the yields of either grafted or own-root plants on 3-year and 2-year soils and the yield on new soil. Likewise there were practically no differences in stem lengths of flowers cut from grafted and own-root plants on new and old soils.

With the possible exception of the first season, the grafted plants gave significantly higher yields than the own-root plants. Over the 3-year period the yield from the own-root plants averaged lower than from the grafted plants by about 4 flowers per plant, or 14 percent.

Experiments With Ophelia, Golden Ophelia, and Silver Columbia Roses

Description of Experiments.—The experiment with Ophelia roses was carried on at the same time and in a similar manner to that described for Premier. The plots were located on the south bench in the same house according to the layout shown in Fig. 3.

With Golden Ophelia and Silver Columbia the method was varied slightly. Young grafted plants in new soil were compared with similar plants newly planted in old rose soil. After the old plants were taken out, the soil was run thru a pulverizer and replaced in the bench over a layer of strawy manure. Fertilizers were added to new and old soils as previously described. The following season the plants which had been in old soil were transplanted to new soil (Fig. 3).

The results with the three varieties are given in Table 12.

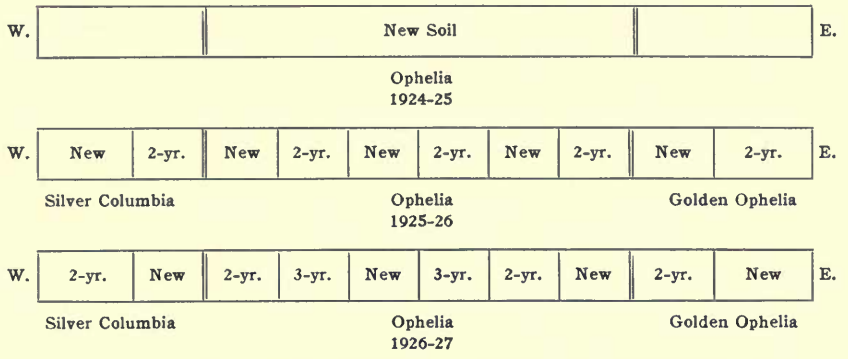

FIG. 3.—LOCATION OF PLOTS IN EXPERIMENT WITH OPHELIA, GOLDEN OPHELIA, AND SILVER COLUMBIA ROSES

Yields on New and Old Soils.—Two-year Ophelia plants which were transplanted into new soil in 1925-26 produced 2.9 flowers (10 percent) more a plant than similar plants which were grown in 2-year soil. In the third season there were no significant differences in yields on new, 2-year, and 3-year soils. Stem lengths were practically uniform on the different plots.

TABLE 12.—FLOWER PRODUCTION OF OPHELIA, GOLDEN OPHELIA, AND SILVER COLUMBIA ROSES ON NEW AND OLD SOILS

Variety and year	Soil	Number of plants	Average number flowers per plant	Average stem length
1924-25				*inches*
Ophelia	New	200	28.79 ± .49	14.9
1925-26				
Ophelia	New	100	28.55 ± .52	14.5
	2-yr.	100	25.65 ± .60	15.2
Golden Ophelia	New	28	27.53 ± 1.19	13.5
	2-yr.	28	21.93 ± .92	11.5
Silver Columbia	New	24	21.58 ± .72	14.7
	2-yr.	24	14.54 ± .76	12.2
1926-27				
Ophelia	New	64	14.78 ± .43	14.6
	2-yr.	68	14.14 ± .43	13.8
	3-yr.	70	15.47 ± .42	14.1
Golden Ophelia	New	28	15.46 ± .69	13.5
	2-yr.	27	14.81 ± .49	13.8
Silver Columbia	New	24	12.37 ± .45	12.8
	2-yr.	24	12.45 ± .50	13.9

Young plants of Golden Ophelia and Silver Columbia on old soil in 1925-26 gave 5.6 flowers (20 percent) and 7.0 flowers (32 percent) a plant less than on new soil. The stems averaged about 2 inches longer on new soil. In the following season there were no significant differences in yields or stem lengths.

Summary and Conclusions in Rose Experiments

Young rose plants planted in old soils gave yields that were materially lower than those grown in new soil. When, however, 2- or 3-year plants were transplanted into new soil there was little or no difference between their yields and the yields of plants of the same age that had been left undisturbed in old soil. Apparently the advantage to be gained from the use of new soil was counterbalanced by the check given the plants in uprooting and transplanting them.

Altho it is a common practice to allow rose plants to remain undisturbed in the bench for three or more years, some growers have advocated and practiced transplanting. Under the conditions of these experiments the changing of rose soil annually was not economical. No noticeable differences were found in the quality of flowers produced on new and on old soils.

Increases in yield, if any, which might be obtained with new soil are not likely to compensate for the trouble and expense of changing the soil.